PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 : B41J 2/18

A1

(11) International Publication Number: WO 93/17869

(43) International Publication Date: 16 September 1993 (16.09.93)

(21) International Application Number: PCT/GB93/00521

(22) International Filing Date: 12 March 1993 (12.03.93)

(30) Priority data:
9205342.0 12 March 1992 (12.03.92) GB

(71) Applicant *(for all designated States except US)*: WILLETT INTERNATIONAL LIMITED [GB/GB]; 3 Cronin Road, Weldon South Industrial Estate, Corby, Northants NN18 8AQ (GB).

(72) Inventor; and
(75) Inventor/Applicant *(for US only)* : SMITH, Mark [GB/GB]; 8 Monument Street, Peterborough PE1 4AQ (GB).

(74) Agent: DUMMETT, Thomas, Ian, Peter; Dummett Copp & Co., 25 The Square, Martlesham Heath, Ipswich, Suffolk IP5 7SL (GB).

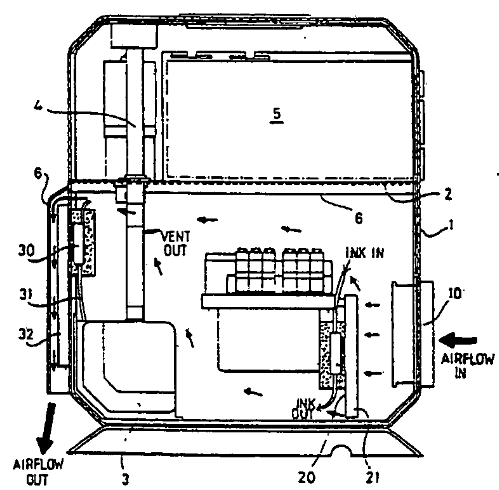
(81) Designated States: AT, AU, BB, BG, BR, CA, CH, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, NZ, PL, RO, RU, SD, SE, UA, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG).

Published
With international search report.

(54) Title: INK RECOVERY SYSTEM

(57) Abstract

The present invention provides a method for optimising the conditions of operation of the ink system of an ink jet printer, characterised in that: (A) the amount of solvent lost from the ink flow system is reduced by bringing at least part of a solvent vapour laden air stream generated from the printer into thermal communication with a Peltier effect device (20) so as to reduce the temperature of the air to below its dew point and thereby condense at least part of the solvent values from the air stream; (B) the temperature of the ink flowing in the ink flow system is regulated by passing at least part of the ink through a second heat device (30) which extracts and/or supplies heat to the ink so as to maintain the temperature of the ink within a desired temperature range; (C) the second heat device (30) and the Peltier effect device (20) dissipate the heat extracted from the air stream and the ink flow via one or more heat sinks (6, 21, 32) to an air stream flowing within a cabinet within which the ink system is housed and the air flow over the heat sink(s) is regulated by a fan means (10) so as to maintain a substantially constant temperature for the ink flowing in the flow ink system. The invention also provides a form of ink jet printer for use in the method of the invention and a heat device for use therein.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	FR	France	MR	Mauritania
AU	Australia	GA	Gabon	MW	Malawi
BB	Barbados	GB	United Kingdom	NL	Netherlands
BE	Belgium	GN	Guinea	NO	Norway
BF	Burkina Faso	GR	Greece	NZ	New Zealand
BG	Bulgaria	HU	Hungary	PL	Poland
BJ	Benin	IE	Ireland	PT	Portugal
BR	Brazil	IT	Italy	RO	Romania
CA	Canada	JP	Japan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo			SE	Sweden
CH	Switzerland	KR	Republic of Korea	SK	Slovak Republic
CI	Côte d'Ivoire	KZ	Kazakhstan	SN	Senegal
CM	Cameroon	LI	Liechtenstein	SU	Soviet Union
CS	Czechoslovakia	LK	Sri Lanka	TD	Chad
CZ	Czech Republic	LU	Luxembourg	TG	Togo
DE	Germany	MC	Monaco	UA	Ukraine
DK	Denmark	MG	Madagascar	US	United States of America
ES	Spain	ML	Mali	VN	Viet Nam
FI	Finland	MN	Mongolia		

Ink recovery system

The present invention relates to a system, notably to a system for the management of the ink flowing in an ink jet printer.

BACKGROUND TO THE INVENTION:

In continuous ink jet printers, ink is fed under pressure by a circulation pump from a reservoir to a print head where it is ejected as a jet of ink from a nozzle orifice. The jet of ink is broken up into a series of substantially uniformly sized and spaced apart droplets by the application of vibration and/or pressure pulses to the ink and/or the nozzle assembly, for example by means of a piezoelectric crystal acting directly on the ink or through a wall of the ink chamber immediately upstream of the nozzle orifice.

The flight path of the droplets is controlled by charging the jet of ink so as to form charged droplets which then pass through a deflecting electric field. By varying the charge on the droplets and/or the strength of the deflecting field, the droplets are diverted to varying extents from their straight line flight to deposit at the desired position on a substrate. Those droplets which are not to be printed are not deflected and are collected in a gutter or other catching means and the ink is then re-cycled to the reservoir, usually by means of a venturi or other pump in the re-cycle line. For convenience, the term continuous jet ink jet printers will be used herein to denote such printers.

During their flight from the nozzle orifice to the gutter or the substrate on which they are printed, the droplets of ink lose part of their solvent carrier medium due to evaporation, so that a solvent vapour rich atmosphere is formed around the gutter. This solvent laden air is sucked into the gutter and thence into the re-cycle line by the suction of the v nturi or other pump used to re-cycle ink from the gutter to th

res rvoir. This suction also caus s further vapour to be formed from the ink as it is re-circulated. Hitherto, this solvent laden air passes with the re-cycled ink into the reservoir and the air is vented to waste. Since the vented air is saturated with solvent vapour, this represents a loss of valuable solvent from the system which must be made up by adding fresh solvent to maintain the desired viscosity of the ink. The venting of the solvent saturated air can also pose health and fire hazards.

Typically, the circulation pump generates a higher flow of ink than is required to be printed onto the substrate at any moment. The excess flow ensures that there is an adequate flow of ink at the required pressure to the print head at peak demand. The excess ink is returned to the reservoir by a by pass circuit. In some systems, part or all of the excess ink flow is fed to the throat of a venturi or other jet pump to generate the suction used to draw ink and solvent vapour from the gutter for re-cycle to the ink reservoir. This may further increase the amount of solvent which evaporates from the ink in the re-cycle line from the venturi pump to the reservoir. Typically, only from 1 to 5% of the ink from the circulation pump passes through the print head.

The ink being circulated through the ink flow system is heated by the action of the gears of the circulation pump and in operating the venturi pump so that the temperature of the ink often varies by up to 30° C from ambient temperature. Part of this heat is dissipated by heat loss from the system and in evaporation of solvent from the ink in its flight from the print head to the gutter and within the re-circulation lines. Operation of the printer thus reaches an equilibrium above ambient temperature at which the heat losses balance the heat input to the ink. However, the heat loss varies with the ambient temperature, so that the operating t mperature of the printer varies from day to day and fluctuates during each day.

With a typical ink composition based on the use of a ketone or other evaporative solvent, the effect of temperature change on the viscosity of the ink can be marked. For example, the viscosity of an MEK based ink at 20°C may be 4cPs, but this is reduced to 3cPs at 30°C. The viscosity of the ink affects its jetting properties and hence the operation of the print head. In order to compensate for the differences in viscosity at the different operating temperatures of a printer, it is customary to vary the pressure at which the ink is fed to the print head so as to achieve uniform droplet size and flight. This introduces complications in the operation of the printer in that some means for varying the ink pressure must be provided and some means for assessing what variation in pressure is required must also be provided, for example an assessment of the flight time of the droplets from the nozzle to the substrate.

The viscosity of the ink is also affected by loss of solvent from the ink as it travels between the nozzle and the gutter and back to the reservoir. It is therefore usually necessary to provide some form of solvent replacement system to compensate for this. This system is usually regulated by measuring the viscosity of the ink and adding solvent in response to changes in the viscosity observed. Again, the viscosity observed will be affected by the operating temperature of the printer and it is usually necessary to apply some temperature compensation factor when calculating the amount of solvent required to be added.

We have now devised a system by which the above problems can be reduced and also heat dissipation from the electronics and other heat generating operating parts of the printer can be enhanced.

SUMMARY OF THE INVENTION:

Accordingly, the present invention provides a method for

optimising the conditions of operation of the ink system of an ink jet printer, characterised in that:

A. the amount of solvent lost from the ink flow system is reduced by bringing at least part of a solvent vapour laden air stream generated from the printer, typically that from the gutter in which ink droplets are collected and/or from the reservoir and/or from one or more conduits through which the ink is recycled to the reservoir, into thermal communication with a Peltier effect device so as to reduce the temperature of the air to below its dew point and thereby condense at least part of the solvent values from the air stream;

B. the temperature of the ink flowing in the ink flow system is regulated by passing at least part of the ink through a second heat device which extracts and/or supplies heat to the ink so as to maintain the temperature of the ink within a desired temperature range;

C. the second heat device and the Peltier effect device dissipate the heat extracted from the air stream and the ink flow via one or more heat sinks to an air stream flowing within a cabinet within which the ink system is housed and the air flow over the heat sink(s) is regulated by a fan means, preferably one whose operation is linked to the ambient temperature so as to maintain a substantially constant temperature for the ink flowing in the flow ink system.

Preferably, the housing containing the ink flow system also contains the electronics controlling the operation of the ink jet printer, typically in a separate chamber within the housing which is hermetically sealed from the compartment of the housing containing the ink flow system, and the air flow passing over the heat sinks of the second heat device and the Peltier effect device passes in heat exchange communication with the control electronics so as to remove heat therefrom.

It is also preferred that the air vent from the ink reservoir discharges adjacent the ink nozzles of the print head so that residual solvent vapour remaining in the air venting from the

ink reservoir is carried with the stream of ink droplets and is sucked into the gutter with the unprinted droplets so as to minimise escape of solvent vapours into the environment.

The invention thus provides an ink jet printer which operates on a substantially closed system with reduced loss of solvent into the environment; in which the temperature of operation of the printer can be maintained at a required and substantially constant level; and in which heat from the electronic control systems can be dissipated.

The invention also provides an ink jet printer through which ink is to flow, preferably one in which the ink is be circulated within the ink flow system of the printer, and from which a solvent laden air stream is to be vented, typically from the ink reservoir, characterised in that:

1. a Peltier effect device is provided in heat exchange communication with one or more conduits through which solvent vapour laden air is to flow so as to extract heat from the solvent laden air and thereby condense out at least part of the solvent values from the air;
2. a second heat device adapted to extract heat and/or to impart heat is provided in heat exchange communication with one or more conduits through which ink is to flow so as to maintain the temperature of the ink within desired levels; and
3. a device is provided to cause air to flow over heat sink members in heat exchange contact with the Peltier effect device and the second heat device so as to extract heat therefrom.

Preferably, one or more heat sinks are provided in heat exchange contact with the electronic control devices for controlling the operation of the printer and the air is caused to flow over those heat sink(s) to dissipate heat from the electronic control devices.

The inv ntion can be applied to any form of ink jet printer in which a solvent vapour laden air stream is formed from which it

is desired to recover at least part of the solvent values. However, the invention is of especial application in continuous ink jet printers to recover solvent values from the air vented from the ink flow system. For convenience, the invention will be described hereinafter in terms of this preferred application.

Due to partial condensation of some of the solvent values from the air stream, part of the solvent values may be present in the air stream as droplets or mist rather than as true vapour. For convenience, the term vapour will be used herein to encompass the case where part of the solvent values are present in the air as droplets or mist as well as the case where all the solvent values are present as evaporated solvent.

In the method of the invention heat is extracted from the solvent laden air stream at any suitable point in the air flow path by the Peltier effect device so as to reduce the temperature of the air stream to below its dew point and thus condense out at least part of the solvent values in the air stream. Preferably, the Peltier effect device is located at the point at which the air stream is vented from the ink system, which is usually at the ink reservoir.

It will also be preferred to cool the air stream by a sufficient amount to recover at least 50% of the solvent values from the air stream. Typically, the air stream will have a temperature of from 15 to 35°C and it will be desired to cool the air stream to from 0 to 10°C. The optimum cooling is a balance between the amount of the solvent which can be recovered and its cost and the cost of operating the Peltier effect device and can be readily determined by simple trial and error tests in any given case.

The Peltier effect heat pump device can be of any suitable type which extracts heat from the air stream. However, it is preferred that the Peltier effect heat pump is of the

thermoelectric type and can take a wide range of forms of such heat pumps, for example a solid state crystalline semi-conductor heat pump, such as one made from a quaternary alloy of bismuth, tellurium, selenium and antimony. Many forms of suitable Peltier effect heat pump are available commercially and may be selected depending upon the physical shape and size requirements as well as the heat load they are to handle.

The Peltier effect heat pump can be of any suitable construction, for example one having a tubular operating element which is fitted around a duct through which the solvent laden air stream flows in indirect heat exchange contact with the element via the duct wall. However, it is preferred that the operating element of the Peltier effect heat pump be in direct thermal contact with the air stream to optimise heat transfer between the air stream and the operative element of the heat pump.

In a particularly preferred embodiment of the invention, the Peltier effect heat pump is in the form of a planar operating element and this forms one wall of a thermally insulated chamber through which the solvent laden air stream flows to provide a simple add-on component which can be inserted into any suitable point in the air flow path, for example at the air vent to the ink reservoir. The chamber is also provided with one or more outlets for the condensed solvent which can be re-cycled to the container from which the make up solvent is drawn to adjust the solvent content of the ink circulating in the ink jet printer.

In such a device, the Peltier effect heat pump is typically provided by a Peltier effect sheet, for example a sheet of a suitable solid state semi-conductor alloy, and the cooling effect is achieved by passing an electric current through that sheet. The amount of heat extracted from the air stream will depend upon the area of the heat pump element and the current passed through the element. The optimum current and area can

readily be determined for any given case.

The Peltier effect heat pump can be operated to extract a constant amount of heat from the air stream, preferably that corresponding to the maximum heat load expected to be required. Alternatively, the Peltier effect heat pump can be operated to extract a variable amount of heat so as to ensure a substantially constant exit air temperature. Where this is done, the operation of the Peltier effect heat pump can be regulated by a temperature sensor downstream of the heat pump which regulates the current flowing through the Peltier effect element. Such control systems can be of conventional design and construction.

The Peltier effect heat pump is preferably provided with one or more heat sinks in thermal contact with the operative element of the heat pump to assist removal of heat from the heat pump element. Such heat sinks can be of conventional design and construction, for example finned aluminium or other high thermal conductivity metal bodies, sleeves or other members attached in heat exchange contact when the operative element. As described below air is passed over the heat sinks to dissipate heat therefrom.

In the invention, heat is also applied to or extracted from the ink circulating in the ink flow system at any suitable point by the second heat device so as to maintain the desired temperature in the ink and hence the desired operating temperature for the printer. Since a substantially uniform operating temperature can be achieved, it is no longer necessary to vary the pressure at which the ink is fed to the nozzle orifice to compensate for temperature variations. Furthermore, since it is not necessary to apply any temperature compensating factors in adjusting the solvent content of the ink in response to monitoring the viscosity of the ink, measurement of the viscosity is simplified and can be used as the sole control on the composition of the ink to achi ve

uniform operation of the print head.

The operation of the second heat device can be used to compensate for excess heat in the ink flow system or to supply heat where loss of heat to the environment is excessive. Where a heat pump is used as the second heat device, this can achieve both heating and cooling effects using a single piece of equipment, thus simplifying the equipment requirements.

The second heat device can act directly upon the flow of ink and it does not require that the ink flow be interrupted or diverted, thus enabling the temperature regulation to be carried out on line. The second heat device can be of sufficient capacity to accommodate wide ranges of heating or cooling requirements so that the temperature of the ink can be regulated over a wide range of ambient temperatures and wide fluctuations of heating or cooling requirement. The second heat device also acts upon the ink enabling a rapid response to temperature fluctuations to be achieved.

The second heat device can be of a wide range of types, and can be one which merely supplies heat to the ink so as to maintain a uniform above ambient temperature. Thus, the heat pump can be a Carnot type heat engine which converts mechanical energy into heat energy. However, it will usually be preferred that the second heat device be a heat pump, notably one exhibiting a Peltier effect, so that it can both supply heat to and extract heat from the ink so that the operating temperature can be selected at either above or below ambient temperature. For example, the second heat device can be of the thermoelectric type and can take a wide range of forms of such heat pumps, for example a solid state crystalline semi-conductor heat pump, such as one made from a quaternary alloy of bismuth, tellurium, selenium and antimony, as described above for the Peltier effect device. In some cases it may be possible to use a single Peltier effect type of heat pump having two chambers to treat th solvent laden air stream in one chamber and to treat

the ink in the other. In such a case, the heat pump may remove excessive amounts of heat from the ink due to the larger degree of cooling which may be required for the air stream. It may therefore be desired to provide a by pass circuit for part of the ink flow so that only part of the ink is cooled to below the desired temperature and this is then admixed with the remainder of the ink to achieve the desired overall temperature. Such by pass circuit and the means for regulating the amount of ink which flows through the Peltier effect heat pump can be of conventional design and operation.

As with the Peltier effect device, the second heat device is preferably provided with one or more heat sinks over which air is passed to dissipate heat from the device.

As stated above, air is passed oven the heat devices to dissipate heat therefrom. Typically, the ink flow system is housed within a cabinet and this is preferably hermetically sealed so that extraneous solvent vapours do not escape into the environment. It is also preferred that, where the cabinet also houses the electronic controls for the printer, these are housed in a second part of the cabinet which is hermetically sealed from that portion of the cabinet housing the ink flow system. The electronic control devices also generate heat and it is preferred that they be mounted upon one or more heat sinks, for example aluminium panels which form the dividing wall between the two portions of the cabinet, which are exposed to the air stream flowing through the portion of the cabinet housing the ink flow system. If desired, the panels can carry finned heat sinks to assist the dissipation of heat into air flowing over them.

The air is caused to flow over the heat sinks carried by the heat devices and the diving wall of the cabinet by any suitable means. Preferably, such means comprise one or more electric fans whose operation is regulated according to the ambient temperature and/or the desired temperature of the ink and/or

the solvent laden air stream to be achieved by the Peltier eff ct and the second heat devices. Such regulation means can be a conventional separate temperature sensor for the ambient temperature which regulates the current and/or voltage applied to the fan motor. Alternatively, the fan can incorporate its own temperature sensor and motor regulatory circuit.

Many forms of suitable fan and temperature responsive controls therefor are available commercially and may be used in the present invention.

DESCRIPTION OF THE DRAWINGS:

To aid understanding of the invention, it will now be described with reference to a preferred form thereof as shown in the accompanying drawings in which Figure 1 is a diagrammatic side view of the cabinet of a continuous jet ink jet printer with one side panel removed to reveal the ink flow system and the air flow path through that; and Figure 2 is a diagrammatic exploded view of a Peltier effect heat pump suitable for use in condensing solvent values from the air vented from the reservoir of the ink flow system or for cooling ink circulating in the ink flow system.

DESCRIPTION OF THE PREFERRED EMBODIMENT:

The ink jet printer comprises a cabinet 1, for example made from metal or plastics panels to form a generally rectangular housing having a transverse wall 2 which sub-divides the housing into an upper compartment which houses the electronic circuitry for controlling the operation of the printer and a lower compartment which houses the ink flow system (not shown) and the ink reservoir 3. The wall 2 preferably carries one or more finned heat sinks (not shown) to aid heat transfer between the upper compartment and the air flowing through the lower compartment.

The lower compartment is provided with a fan 10 for circulating air through the lower compartment as indicated by the arrows. The air flow over the components in the lower compartment dissipates heat generated therefrom.

Ink in the ink flow system flows through a heat pump 20 which comprises a chamber which has one wall formed from a sheet of Peltier effect material. When a current is passed through the sheet, heat is removed from the ink to achieved a desired temperature. Ink which is not printed is recycled as described above to the reservoir 3 and in doing so a solvent laden air stream is vented from the reservoir 3 via a vent 4 which is directed back to the environs of the outlet nozzles for the ink at the print head (not shown) so that effectively a closed air circulation loop is formed between the reservoir and the print head to minimise loss of solvent vapour to the atmosphere.

The solvent laden air venting from the reservoir 3 is passed through a second Peltier effect heat pump 30 which is of essentially the same construction as heat pump 20. Heat pump 30 cools the air stream to below its dew point and condenses out at least part of the solvent values in the air stream before it is recycled to the print head. The solvent condensate is returned to the ink reservoir via line 31 to make up at least in part for the solvent evaporated from the ink.

The Peltier effect heat pumps 20 and 30 are shown diagrammatically in Figure 2 and comprise a generally rectangular housing 40 defining an internal chamber having an inlet 41 and an outlet 42. The chamber walls are typically made from a metal inner wall having an outer plastic or other thermally insulating layer, or from a thermally insulating plastic so as to reduce incidental heat gains through the walls of the chamber.

One wall of the chamber is provided with a Peltier effect heat pump element 43 which is removably mounted on the housing so

that one face of the heat pump is in thermal contact with the interior of the chamber. Preferably, as shown, the housing 40 is formed with one open face 44 and the heat pump element 43 is mounted on the housing to form a wall of the chamber at that face and in direct thermal contact with air or ink within the chamber. The element preferably is sheet of a solid state semi-conductor alloy.

In operation, ink flows through pump 20 and is cooled to the desired temperature as it flows to the print head. Ink from the gutter catching the non-printed droplets from the print head is re-cycled to reservoir and forms a solvent laden air stream which is vented by vent 4 to pump 30. The air stream is cooled, typically to about 5°C, to condense out the majority of the solvent values which are returned to the reservoir 3 via line 31. The cooled air stream exits heat pump 30 and returns to the print head.

The operation of the electronic control devices 5 in the upper compartment of the cabinet, and of heat pumps 20 and 30 produces heat. This is dissipated by the air stream from fan 10 passing oven the finned heat sinks 6, 21 and 32 carried by wall 2 and the heat pumps 20 and 30 and exits from the cabinet via outlet 6. If desired, the heat sinks 32 for heat pump 30 can be located in the outlet 6, as shown, where they would be too large to accommodate within the cabinet.

CLAIMS:

1. A method for optimising the conditions of operation of the ink system of an ink jet printer, characterised in that:
A. the amount of solvent lost from the ink flow system is reduced by bringing at least part of a solvent vapour laden air stream generated from the printer into thermal communication with a Peltier effect device so as to reduce the temperature of the air to below its dew point and thereby condense at least part of the solvent values from the air stream;
B. the temperature of the ink flowing in the ink flow system is regulated by passing at least part of the ink through a second heat device which extracts and/or supplies heat to the ink so as to maintain the temperature of the ink within a desired temperature range;
C. the second heat device and the Peltier effect device dissipate the heat extracted from the air stream and the ink flow via one or more heat sinks to an air stream flowing within a cabinet within which the ink system is housed and the air flow over the heat sink(s) is regulated by a fan means so as to maintain a substantially constant temperature for the ink flowing in the flow ink system.

2. A method as claimed in claim 1, characterised in that the housing containing the ink flow system also contains the electronics controlling the operation of the ink jet printer in a separate chamber within the housing which is hermetically sealed from the compartment of the housing containing the ink flow system, and the air flow passing over the heat sinks of the second heat device and the Peltier effect device passes in heat exchange communication with the control electronics so as to remove heat therefrom.

3. A method as claimed in either of claims 1 or 2, characterised in that at least 50% of the solvent values in the air stream are condensed out by the cooling effect of the Peltier effect device.

4. A method as claimed in any one of the preceding claims, characterised in that the airstream from which the solvent values are to be recovered has a temperature of from 15 to 35°C and is cooled to from 0 to 10°C.

5. A method as claimed in any one of the preceding claims, characterised in that the air stream containing the solvent values flows through a chamber having one wall at least in part formed from the operative element of a Peltier effect device.

6. A method as claimed in any one of the preceding claims, characterised in that the second heat devices acts to cool the ink to maintain a predetermined above ambient temperature.

7. A method as claimed in either of claims 1 or 6, characterised in that the second heat device is a Peltier effect device.

8. A method as claimed in either of claims 5 or 7, characterised in that the Peltier effect device comprises a.a rectangular, tubular or other shaped housing formed from a thermally insulating material; and
b. one or more Peltier effect heat pump operative elements incorporated into at least one wall of the housing;
the housing defining a chamber having a fluid inlet, a fluid outlet and, where the device is to condense solvent values from an air stream, a condensed solvent outlet, which may also serve as the fluid outlet, through which chamber the air or ink stream is adapted to flow in thermal contact with the heat pump element(s); the heat pump element(s) being adapted to be connected to an electric current supply so as to cause the heat pump element(s) to cool and/or heat the fluid stream.

9. A method as claimed in claim I, characterised in that a single device provid s both the Peltier effect device and the second heat device.

10. A method as claimed in any one of the preceding claims, characterised in that the air stream from which at least part of the solvent values have been recovered is discharged adjacent the nozzles of the print head of the printer.

11. A method as claimed in any one of the preceding claims, characterised in that the ink jet printer is a continuous jet printer.

12. A method as claimed in claim 1, substantially as hereinbefore described with respect to the accompanying drawings.

13. A heat device suitable for use as the Peltier effect device and/or the second heat device in the method as claimed in claim 1, characterised in that the heat device comprises:
a. a rectangular, tubular or other shaped housing formed from a thermally insulating material; and
b. one or more Peltier effect heat pump operative elements incorporated into at least one wall of the housing;
the housing defining a chamber having a fluid inlet, a fluid outlet and, where the device is to condense solvent values from an air stream, a condensed solvent outlet, which may also serve as the fluid outlet, through which chamber the air or ink stream is adapted to flow in thermal contact with the heat pump element(s); the heat pump element(s) being adapted to be connected to an electric current supply so as to cause the heat pump element(s) to cool and/or heat the fluid stream.

14. An ink jet printer through which ink is to be circulated within the ink flow system of the printer, and from which a solvent laden air stream is to be vented, characterised in that:
a. a Peltier effect device is provided in heat exchange communication with one or more conduits through which solvent vapour laden air is to flow so as to extract heat from the solvent laden air and thereby condense out at least part of the

solvent values from the air;

b. a second heat device adapted to extract heat and/or to impart heat is provided in heat exchange communication with one or more conduits through which ink is to flow so as to maintain the temperature of the ink within desired levels; and

c. a device is provided to cause air to flow over heat sink members in heat exchange contact with the Peltier effect device and the second heat device so as to extract heat therefrom.

14. An ink jet printer as claimed in claim 15, characterised in that the ink flow system of the printer is contained in a housing and the electronic control circuitry for operating the printer is housed in a portion of that housing separated from the ink system by a thermally conductive partition; and in that one or more heat sinks are provided in heat exchange contact with the electronic control devices for controlling the operation of the printer and the air is caused to flow over those heat sink(s) to dissipate heat from the electronic control devices.

16. An ink jet printer as claimed in claim 14, substantially as hereinbefore described with respect to and as shown in the accompanying drawings.

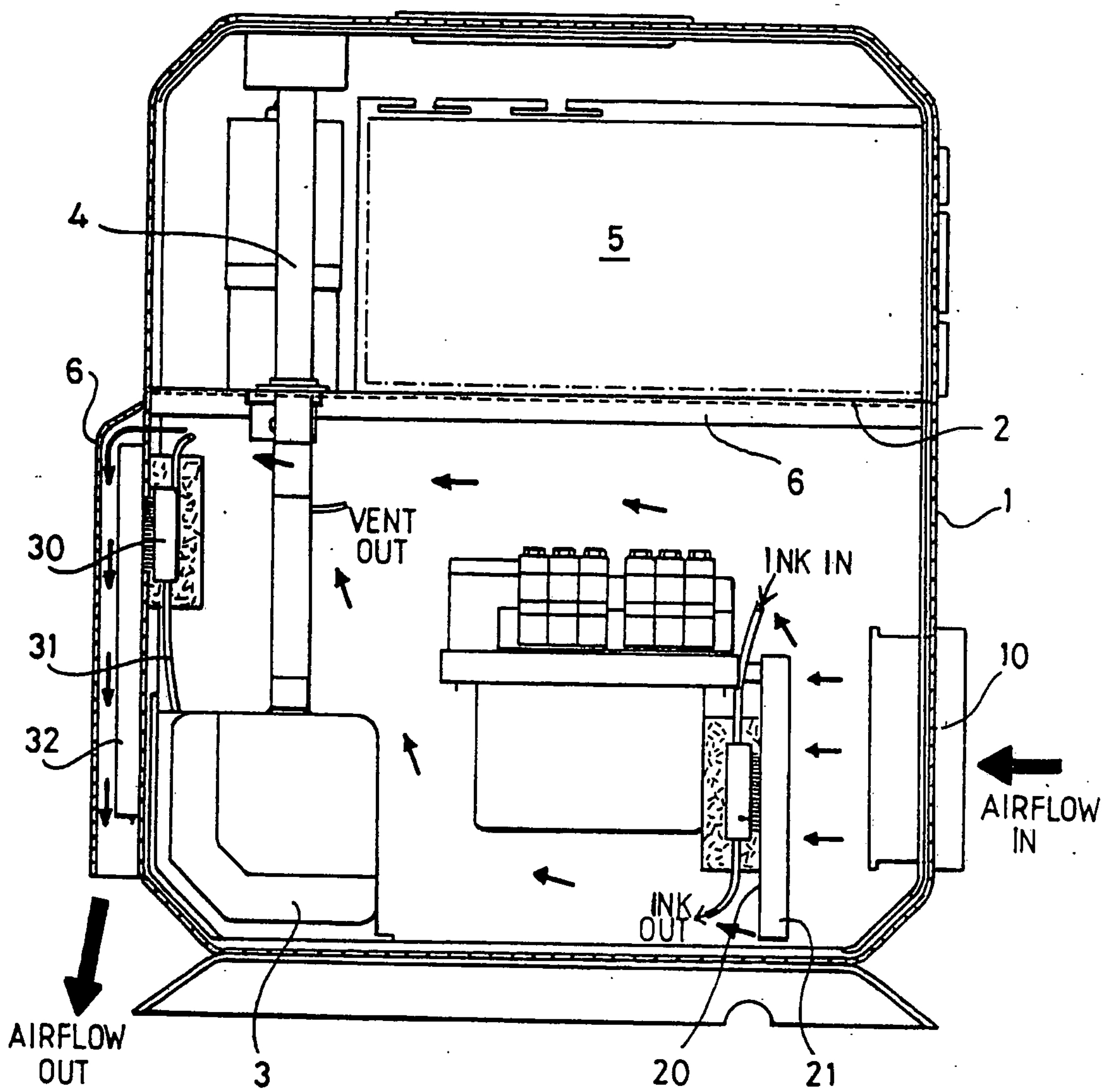

4
5
6
2
6
1
VENT OUT
30
INK IN
31
10
32
AIRFLOW IN
INK OUT
AIRFLOW OUT
3
20
21

Fig. 1

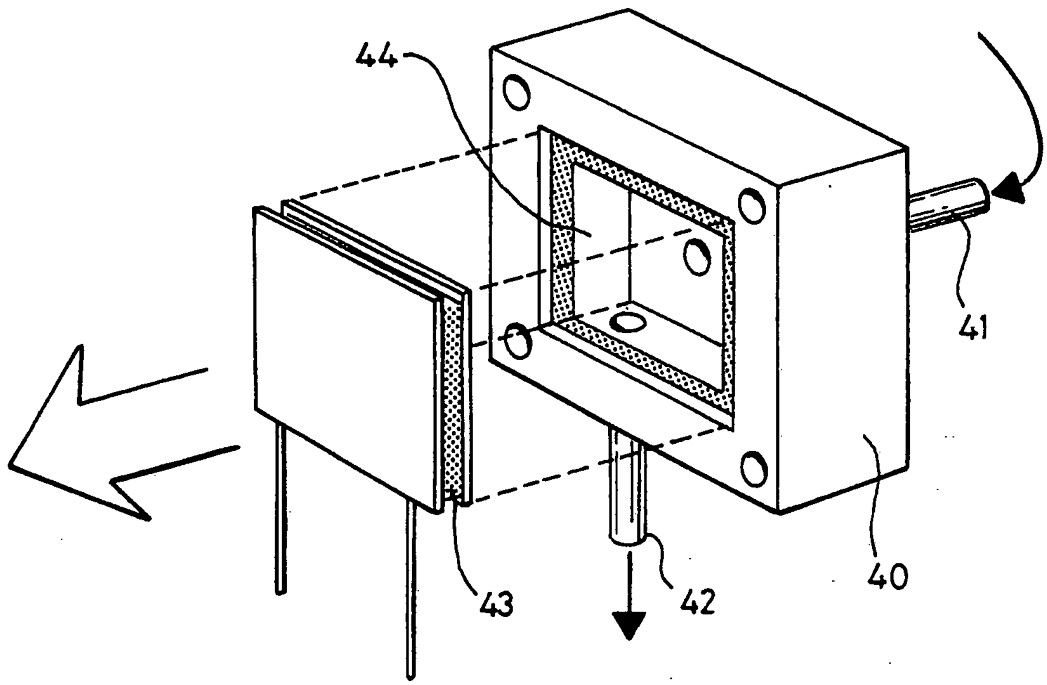


Fig. 2

INTERNATIONAL SEARCH REPORT

International Application No PCT/GB 93/00521

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B41J2/18

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B41J

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category°	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	IBM TECHNICAL DISCLOSURE BULLETIN vol. 25, no. 3A, August 1982, pages 947 - 947 DRISCOLL, P.R. ET AL. 'EVAPORATION RECOVERY SYSTEM' see the whole document ---	1-16
X	IBM TECHNICAL DISCLOSURE BULLETIN vol. 24, no. 4, September 1981, page 1817 BEACH, B.L. ET AL. 'GUTTER TEMPERATURE CONTROL FOR INK JET PRINTERS' see the whole document ---	1,13,14
A	PATENT ABSTRACTS OF JAPAN vol. 4, no. 25 (M-1)(507) 5 March 1980 & JP,A,55 000 275 (OKI DENKI KOGYO K.K.) 5 January 1980 see abstract ---	1-16
	-/--	

° Special categories of cited documents :[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

1

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
10 JUNE 1993	29. 06. 93
International Searching Authority	**Signature of Authorized ffficer**
EUR PEAN PATENT FFICE	JOOSTING T.E.

International Application No PCT/GB 93/00521

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)

Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	US,A,4 360 817 (ARWAY ET AL.) 23 November 1982 see claim 1; figure 1	1-16
A	PATENT ABSTRACTS OF JAPAN vol. 6, no. 36 (M-115)(914) 5 March 1982 & JP,A,56 151 568 (RICOH K.K.) 24 November 1981 see abstract	1-16
A	PATENT ABSTRACTS OF JAPAN vol. 9, no. 272 (M-425)30 October 1985 & JP,A,60 115 450 (SANYO DENKI K.K.) 21 June 1985 see abstract	1-16

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. GB 9300521 SA 71179

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on 10/06/93
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US-A-4360817	23-11-82	CA-A-	1179551	18-12-84
		DE-A,C	3218342	02-12-82
		GB-A,B	2098546	24-11-82
		JP-C-	1636224	31-01-92
		JP-B-	2062394	25-12-90
		JP-A-	57199665	07-12-82